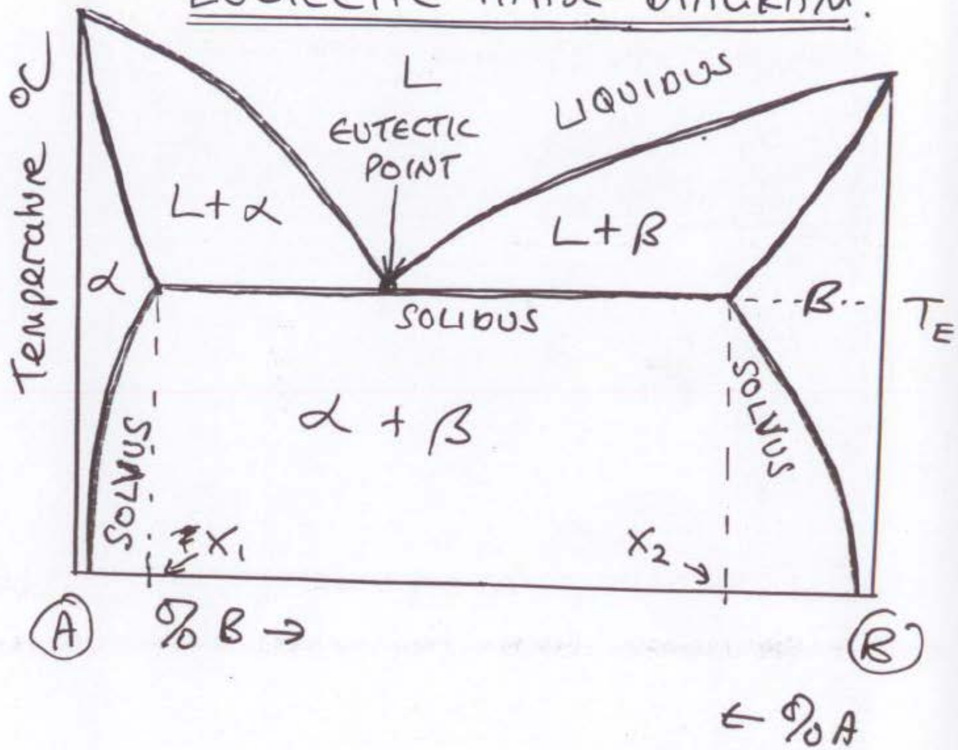
EUCTECTIC PHASE DIAGRAM.



Any alloy between the compositions of X_1 and X_2 undergoes the eutectic reaction – ie solid α and β forms simultaneously at the eutectic temperature T_E.

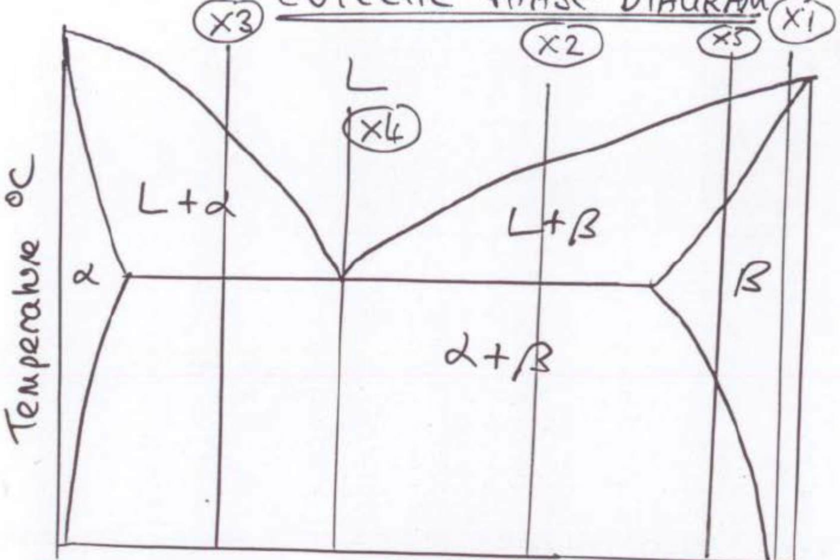
Liquidus:
Anything above is liquid

Solidus:
Anything below is solid

Eutectic reaction:
$L \rightarrow \alpha + \beta$

At one temperature = **invariant**

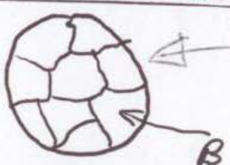
EUTECTIC PHASE DIAGRAM



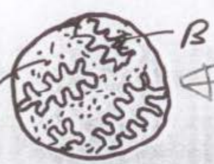
X5 

As X1, but α forms on grain boundaries

MICROSTRUCTURES:-

X1 

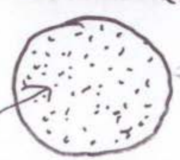
Solid β forms first and continues until as solid β

X2 

Solid β forms first. At T_E, eutectic forms → α + β

X3 

Solid α forms first, At T_E eutectic forms → α+β

X4 

Cools down until the eutectic temperature T_E → eutectic α + β forms.

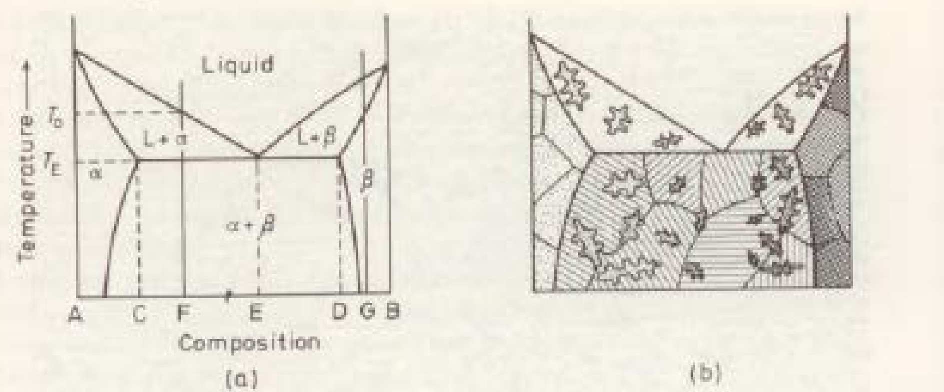


Figure 4.30 (a) Eutectic equilibrium diagram with all the phase fields marked. (b) Schematic drawing of the development of different morphologies in all alloys across the equilibrium diagram

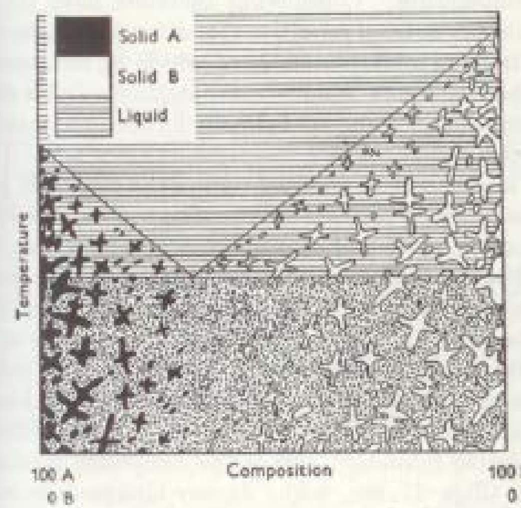
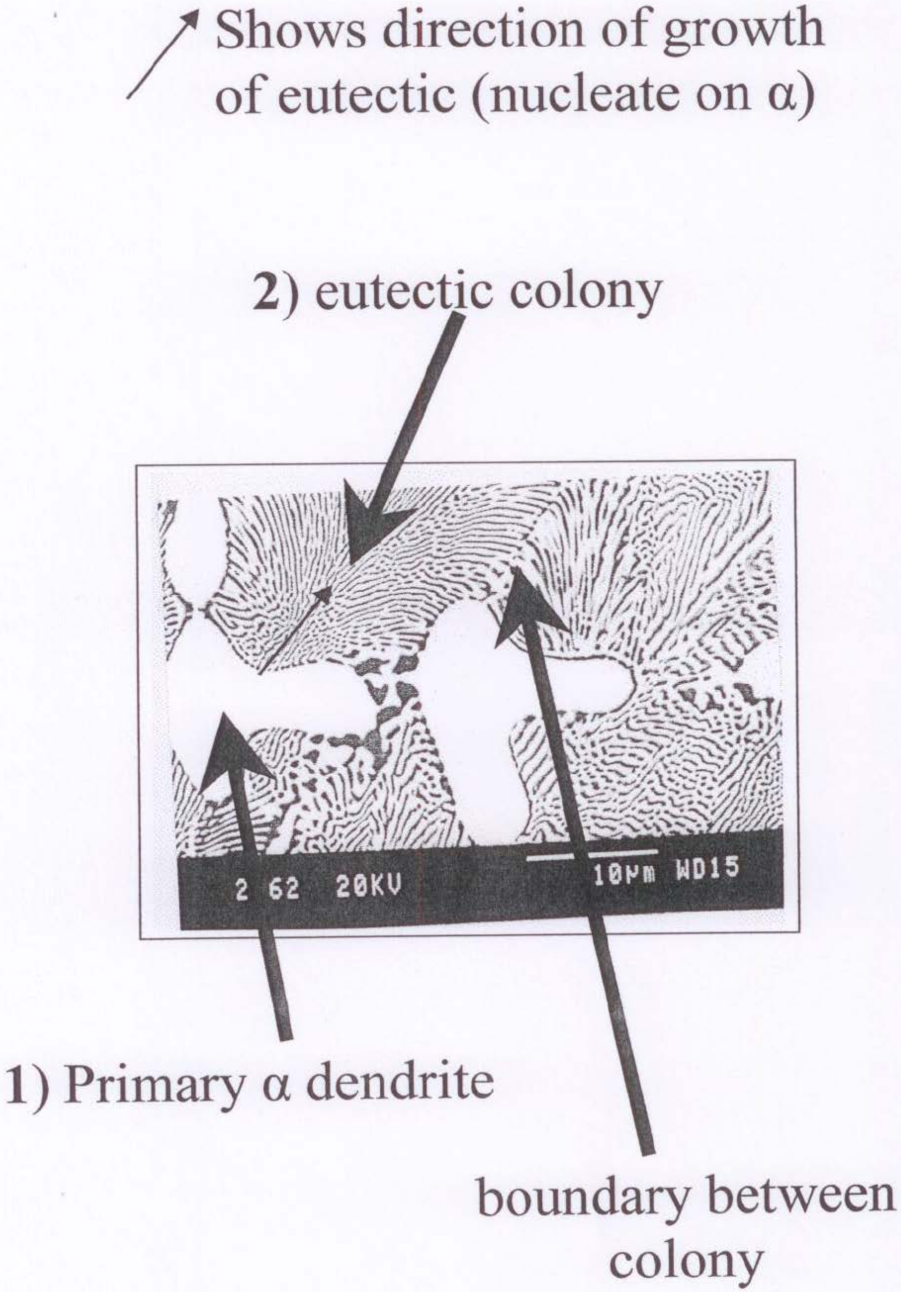
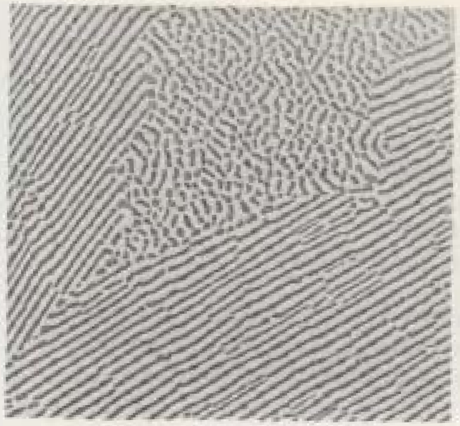
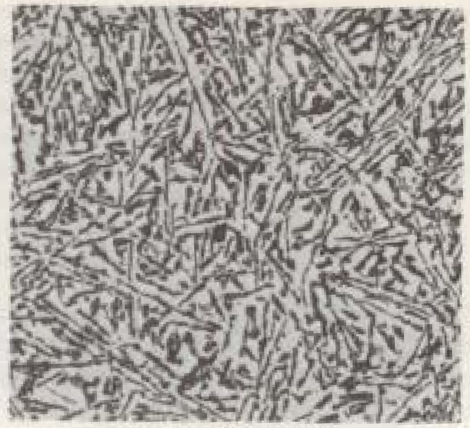


FIG. 35. Sketch showing microstructures in simple eutectic system.
Note: the photographs in FIG. 42 and 43, although of alloys involving solid solutions, are typical of eutectic systems and should be compared with this sketch.


Shows direction of growth of eutectic (nucleate on α)
2) eutectic colony
2 62 20KV
10μm WD15
1) Primary α dendrite
boundary between colony



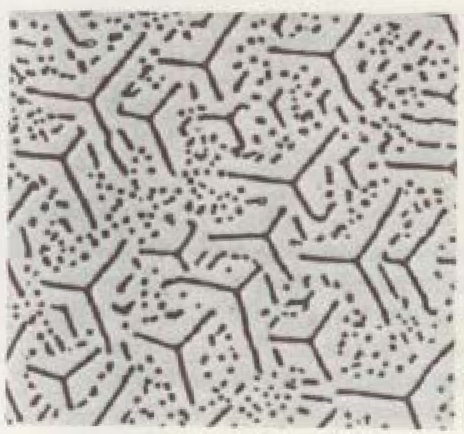
(a) Cu–Ag *(x 250)*



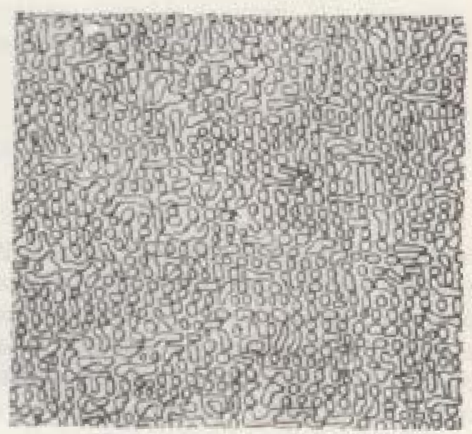
(b) Al–Si *(x 150)*

(c) Zn–$MgZn_2$ *(x 500)*

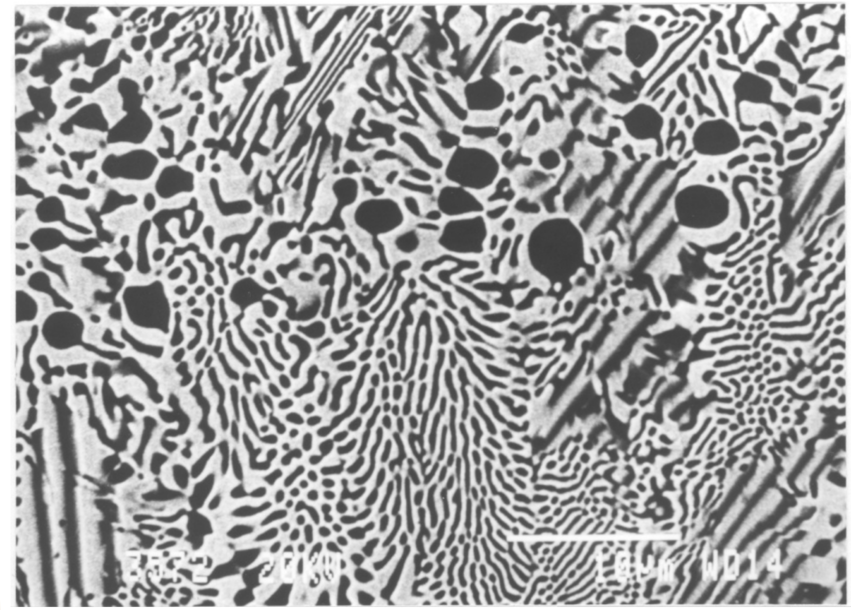
(d) Cd–Bi *(x 500)*

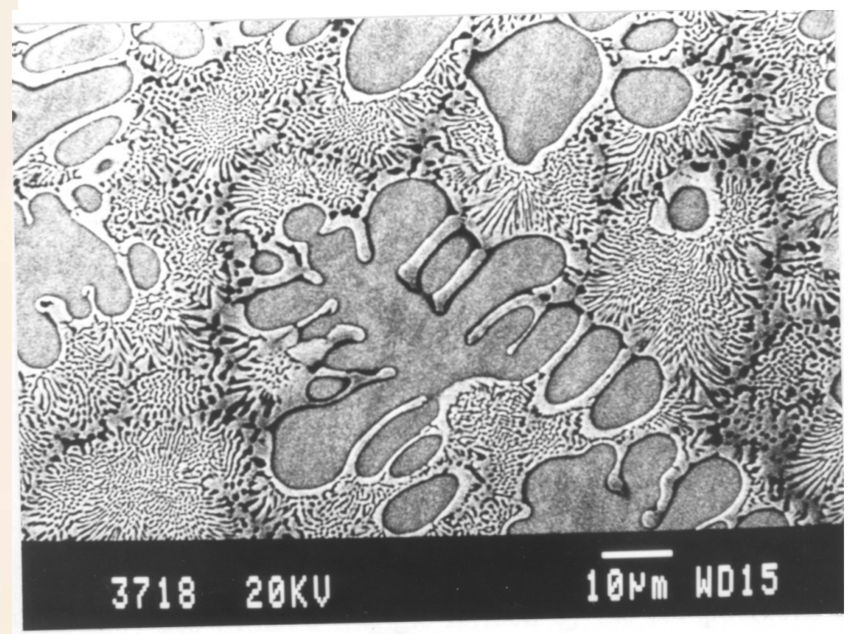


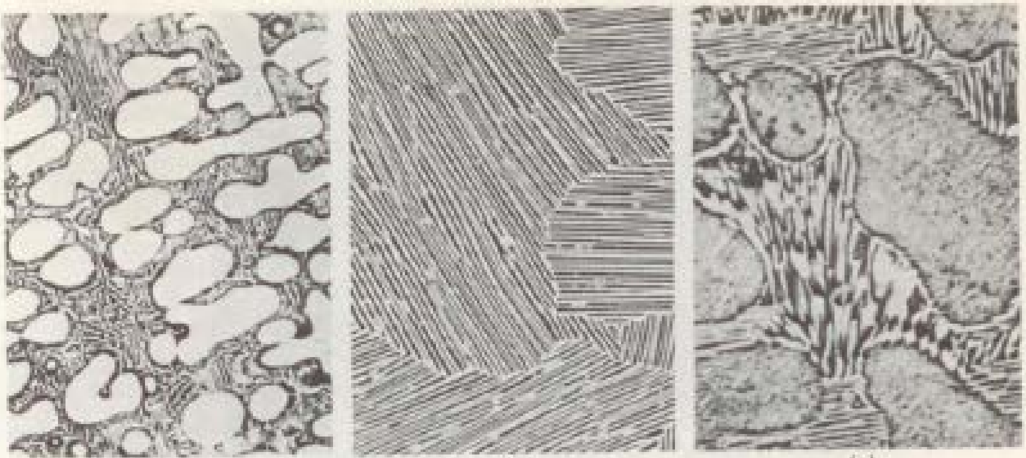
(e) Co–TaC *(x 700)*



(f) Fe–Fe_2B *(x 300)*





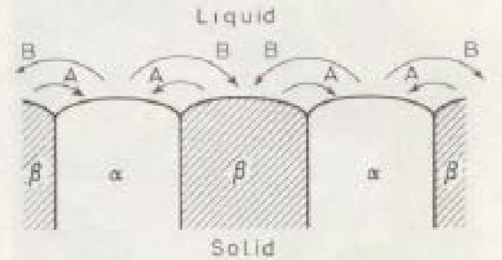


(a) (b) (c)

Figure 4.35 *Microstructures of silver–aluminium alloys of three different compositions. (a) Hypo-eutectic; non-faceted dendrites of the Ag_2Al compound in a eutectic matrix (x 350). (b) Eutectic alloy; lamellar microstructure (x 150). (c) Hyper-eutectic; non-faceted Al-rich dendrites in eutectic matrix. (x 350)*

(a) (b) (c)

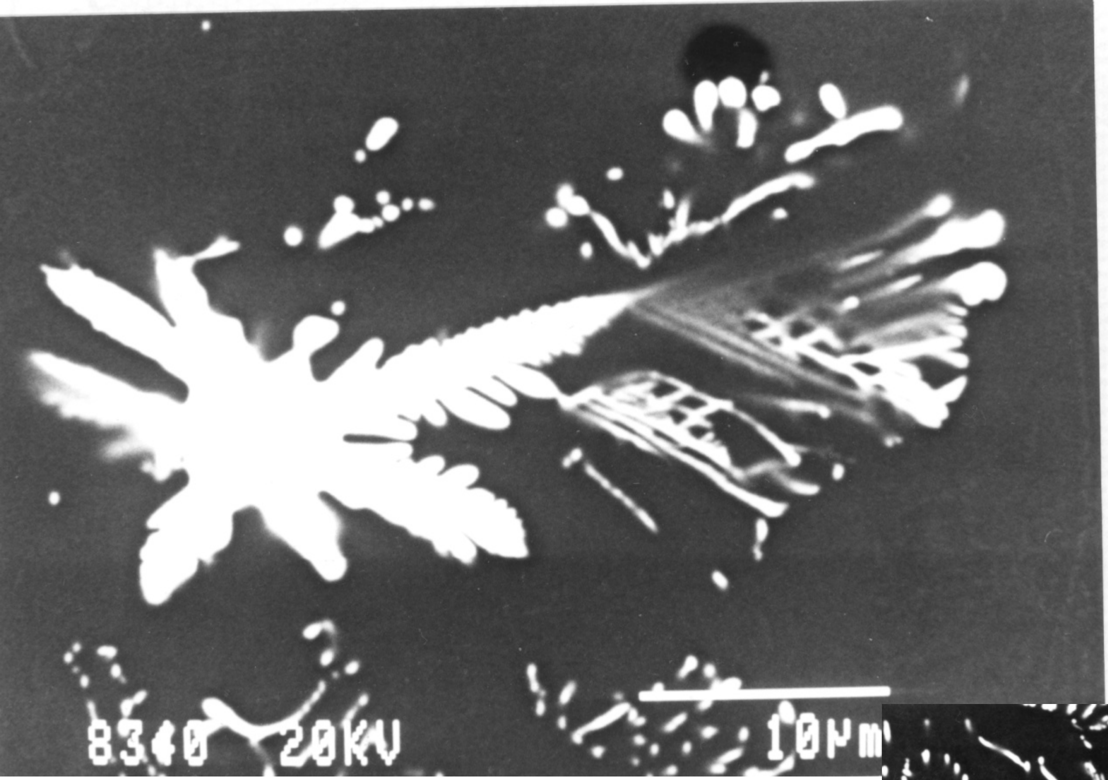
Figure 4.36 *Typical metal–metal eutectic microstructures, transverse sections: (a) lamellar; (b) ribbon-like; (c) fibrous*



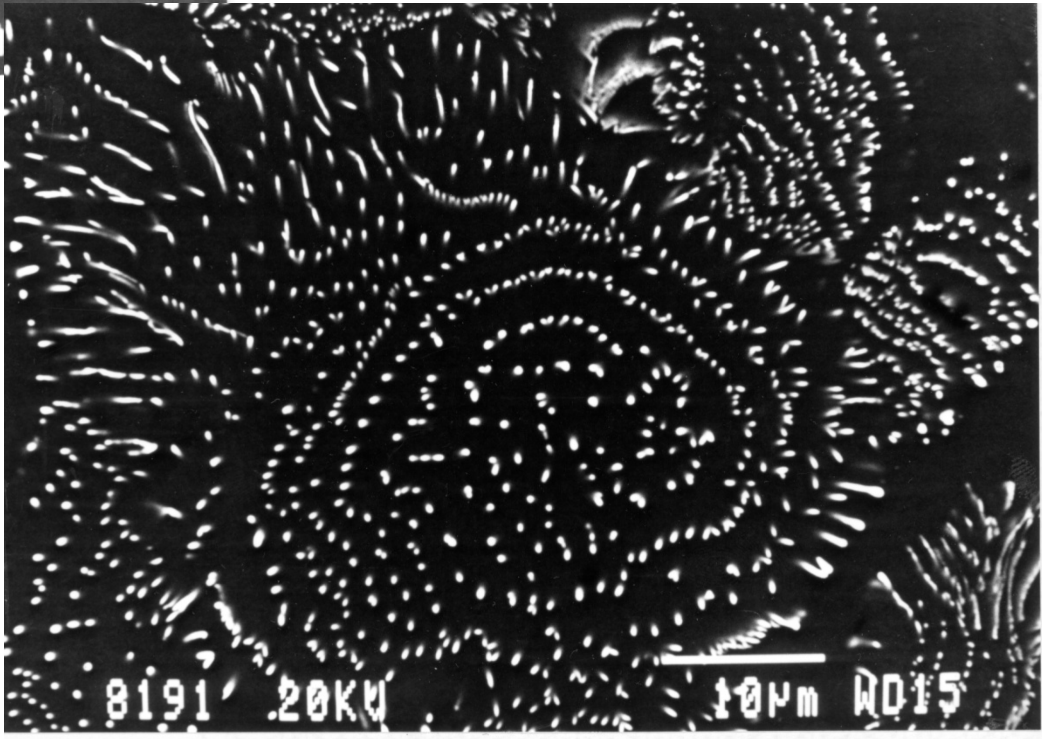
Idealised shape of eutectic solid–liquid interface showing the cross-diffusion of solute ahead of the interface

Figure 4.69 *Transverse microstructure of Al–Si; grown at a very slow growth rate and in a steep temperature gradient (x 50) (Courtesy of M. G. Day[31])*

Figure 4.70 *Fibrous silicon morphology in a rapidly frozen Al–Si eutectic alloy (x 15 000) (Courtesy of M. G. Day[31])*



←First phase of the eutectic to grow often grows on the pro-eutectic phase



Different views of the same eutectic

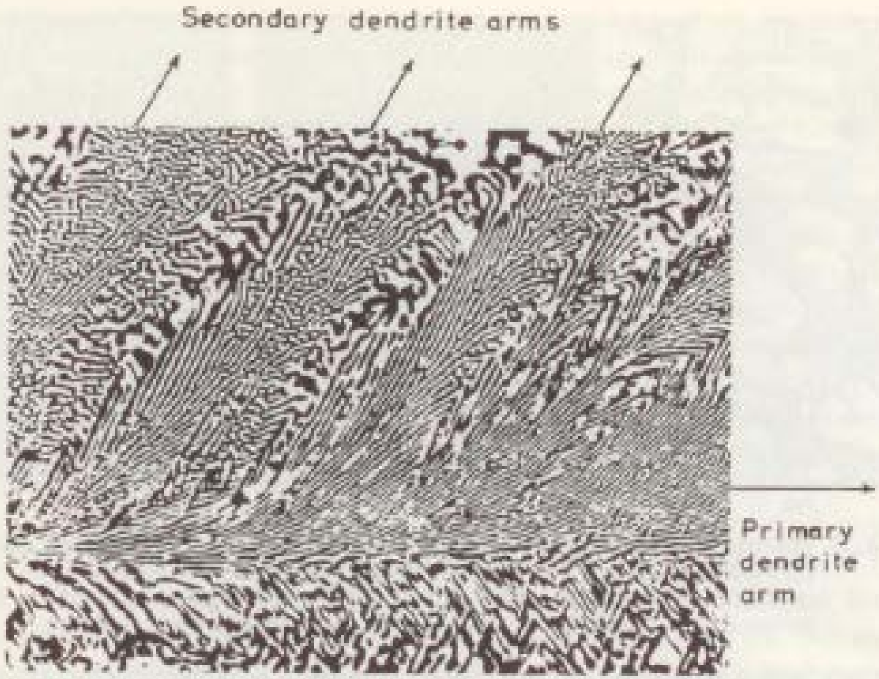
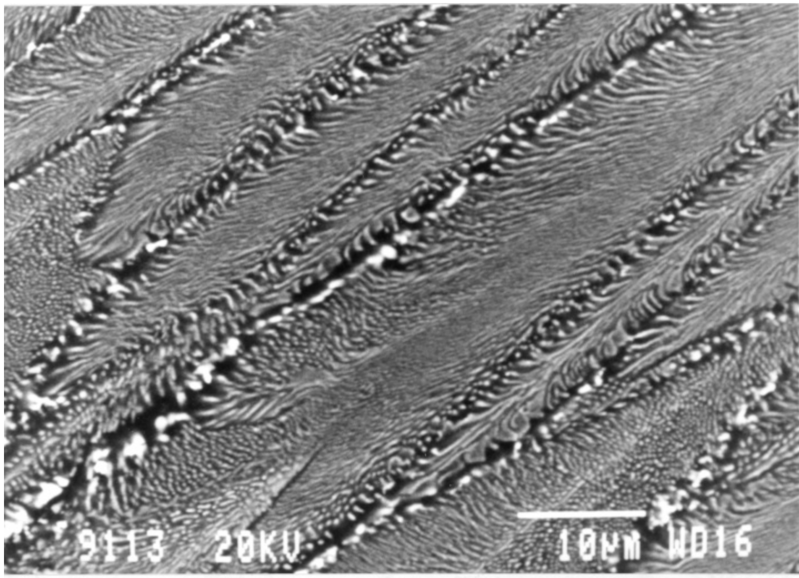
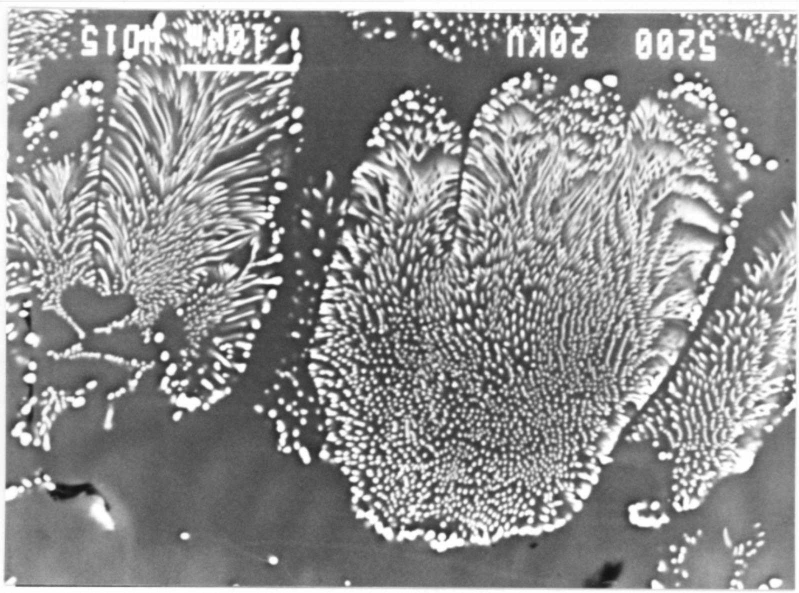
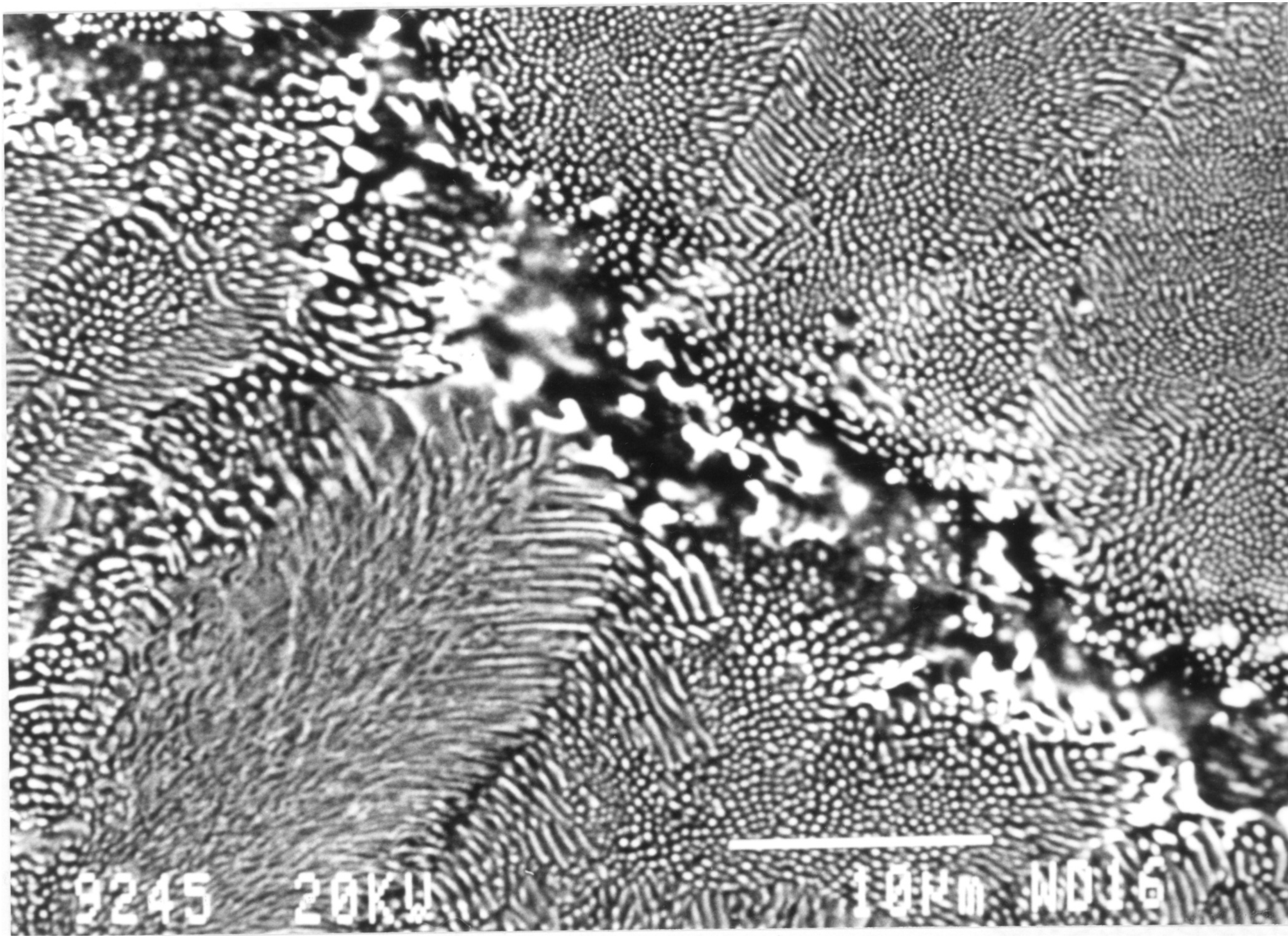


Figure 4.38 Dendritic eutectic morphology found in very rapidly solidified Al–$CuAl_2$ alloy (x 500). (Courtesy of C. M. Adams[9])



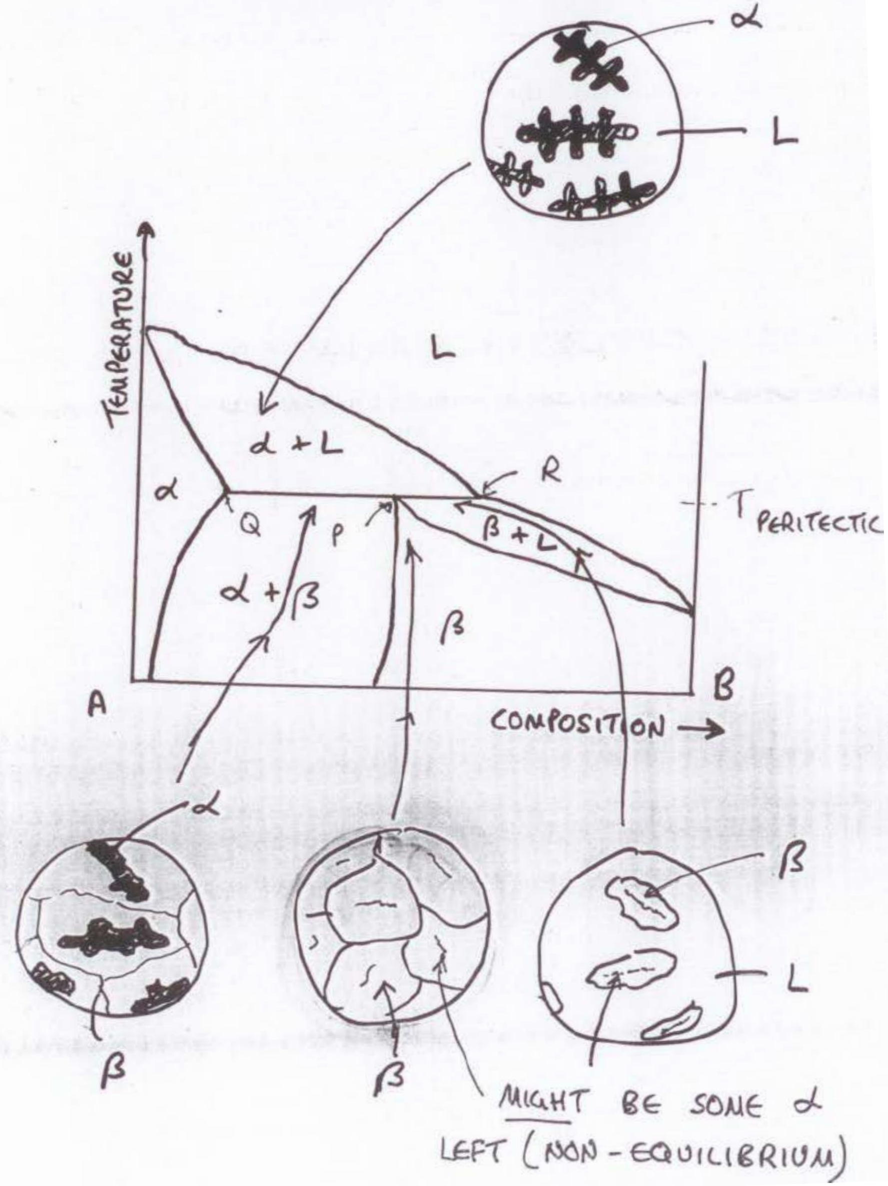


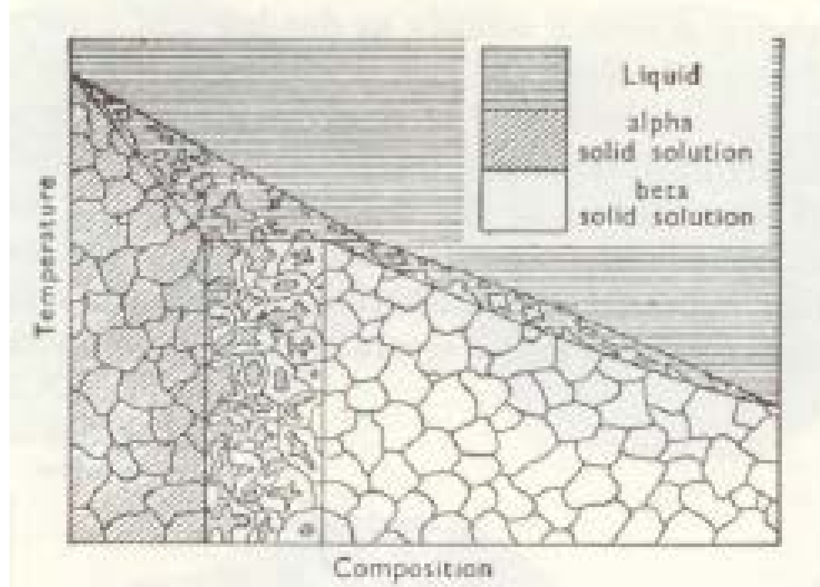
Eutectic colonies


9245 20KV 10Pm WD16

Peritectic Microstructures

$L + \alpha \rightarrow \beta$





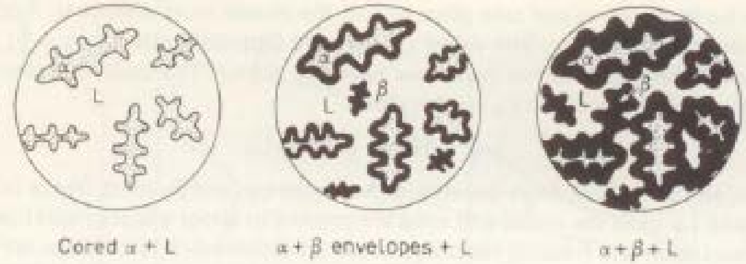


Figure 4.85 Schematic drawing of peritectic reaction as it actually occurs

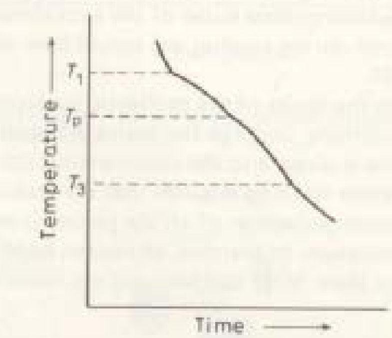
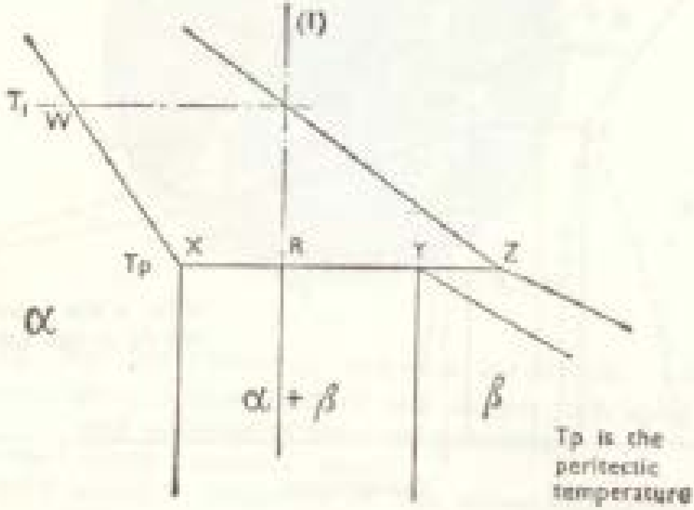
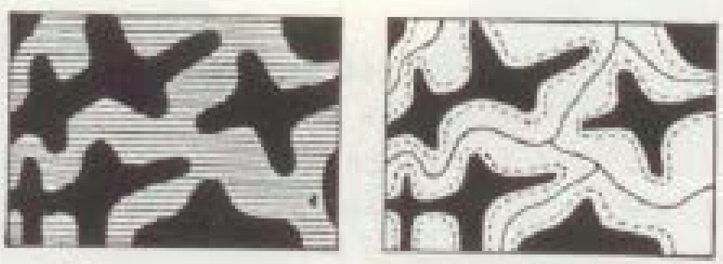


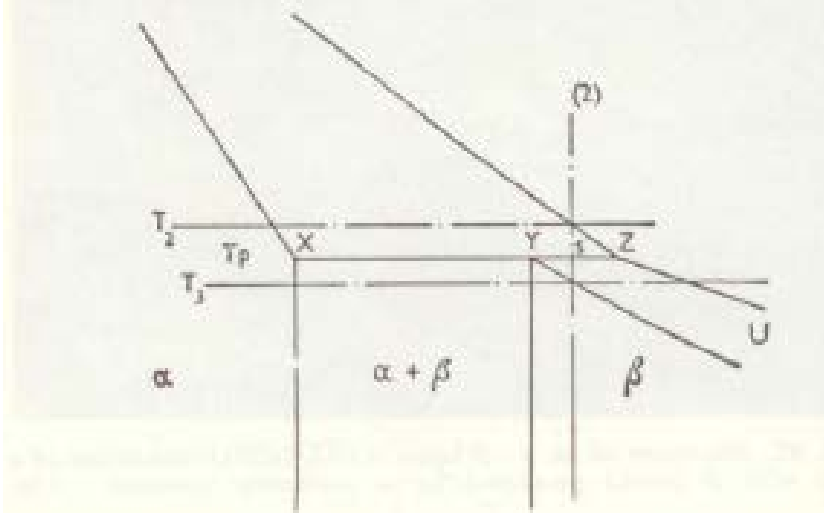
Figure 4.86 Thermal analysis of peritectic reaction

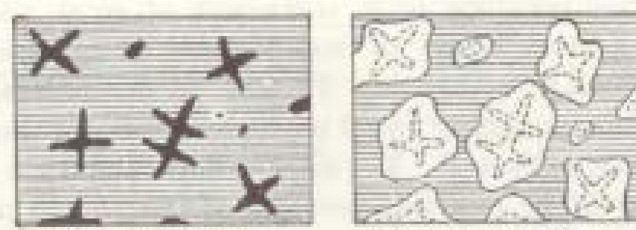




(a) Structure on reaching Tp

(b) Structure after peritectic reaction

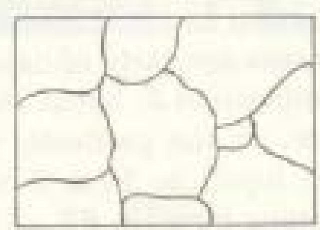




(a) Structure on reaching Tp

(b) Structure after peritectic reaction

Code



(c) Structure at T_3 : completely solid as grains of β of composition S

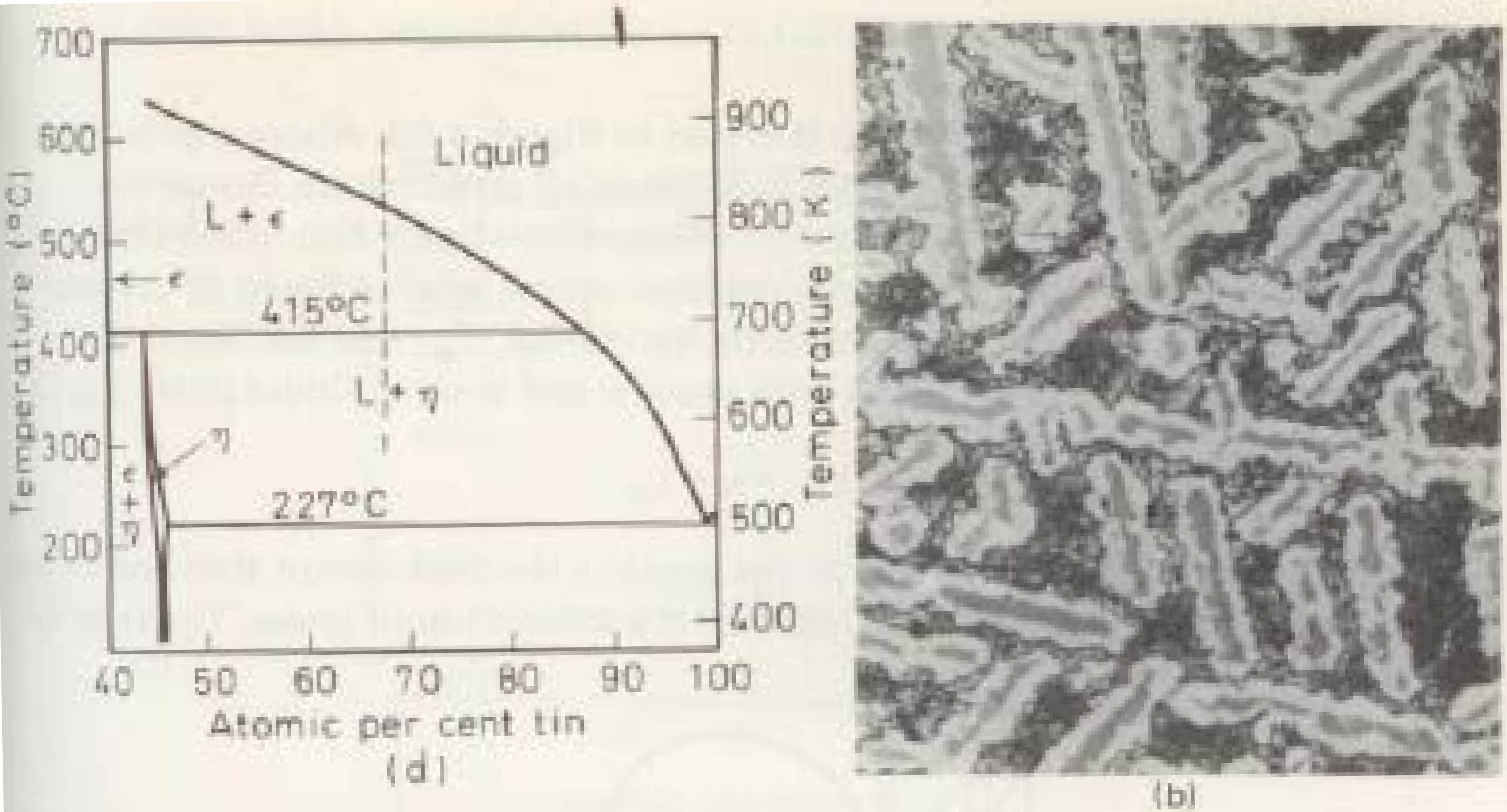
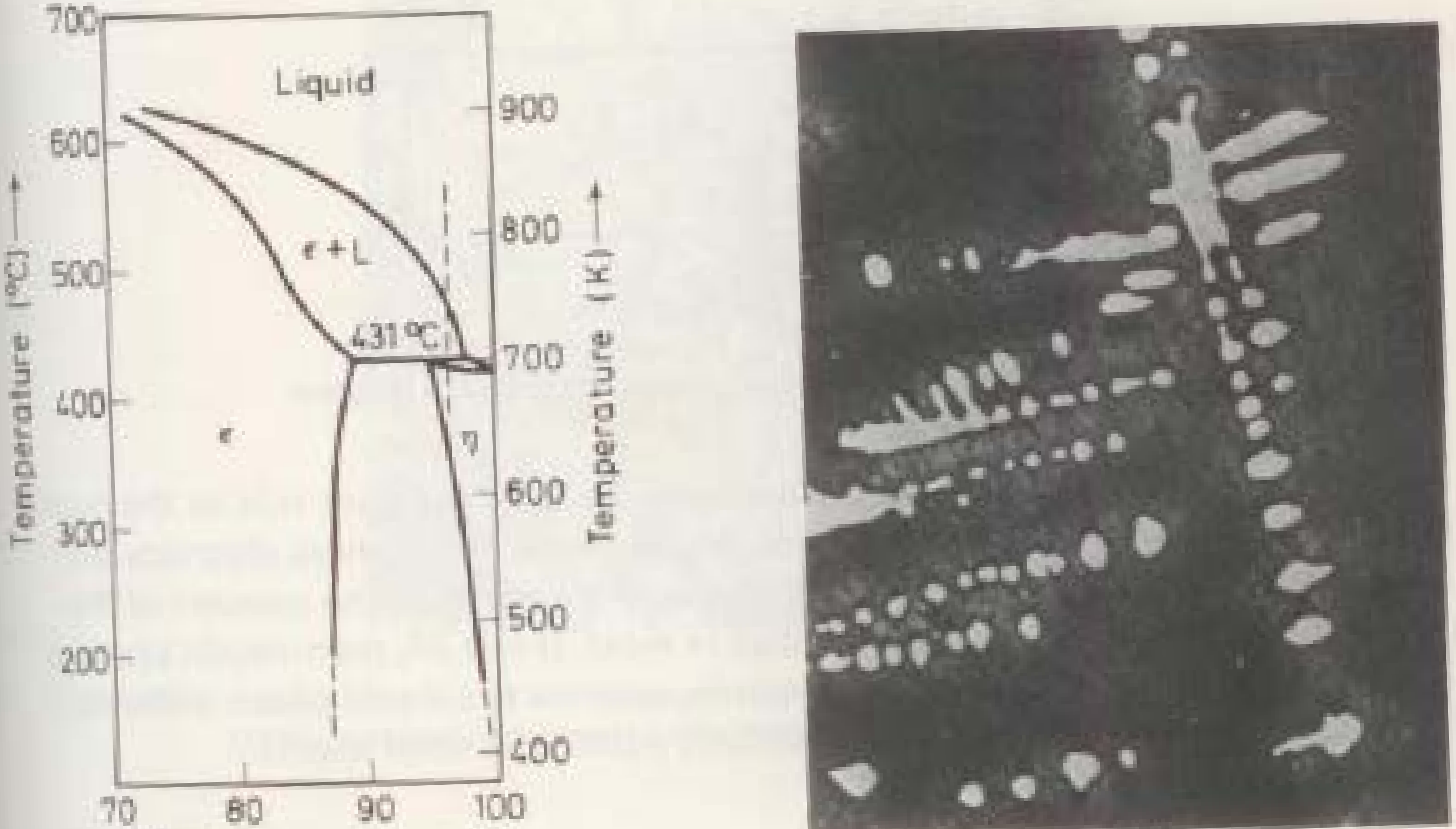


Figure 4.87 (a) Part of the copper–tin equilibrium diagram. (b) Microstructure of Sn–35 at % Cu alloy, showing primary crystals of ε (grey phase) coated with η (white phase) in matrix of eutectic (mottled regions)

Peritectic reaction: L + ε → η

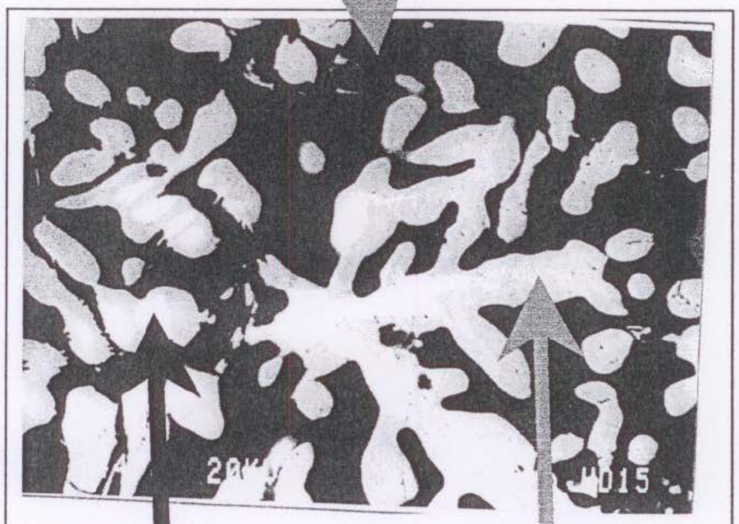
Peritectic reaction: L + ε → η

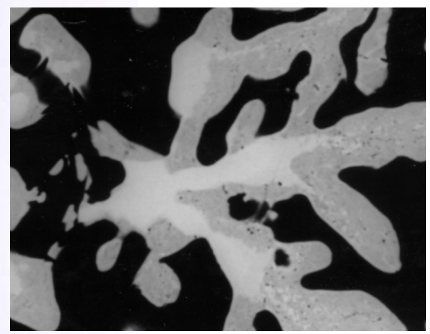


(a) (b)

Figure 4.88 (a) Part of the silver–zinc equilibrium diagram. (b) The microstructure of the zinc–3·5 at % Ag alloy: primary dendrites of ε-phase in a zinc-rich matrix

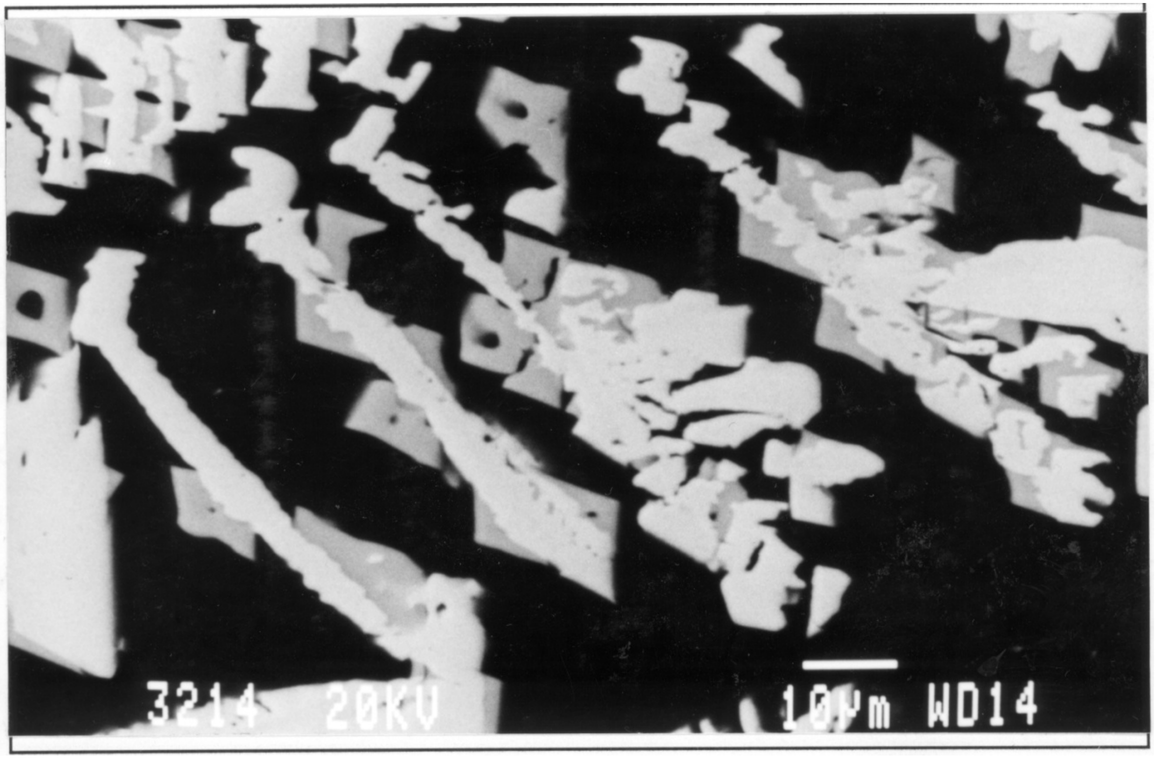
3) sparse (i.e. not very much of the other phase)
β + γ

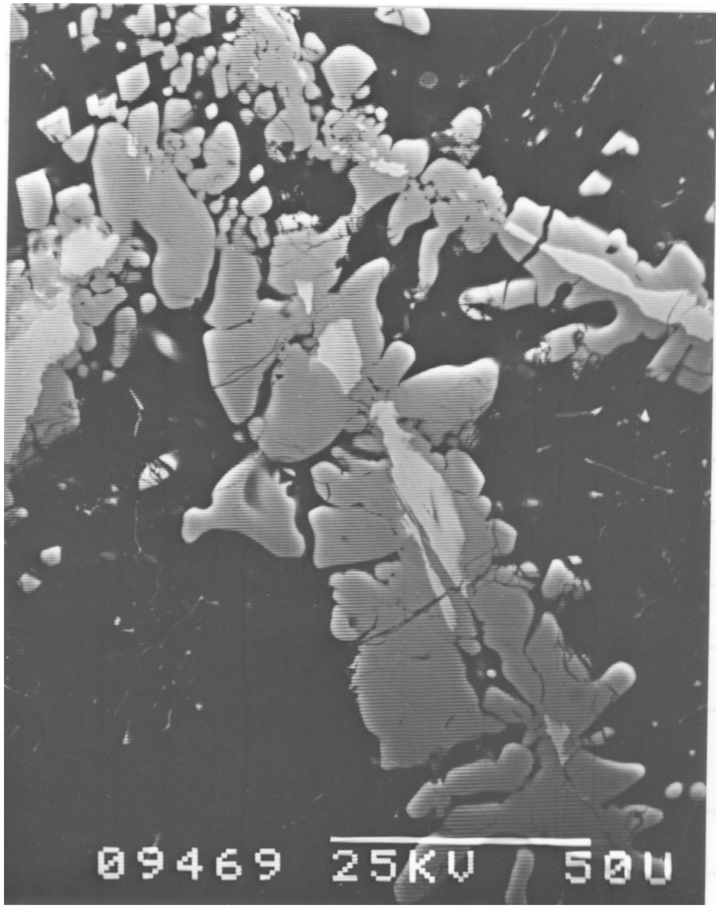




1) Primary α

2) β formed from peritectic reaction
L + α → β





Examples of peritectic reactions

Cascades of peritectic reactions

Might expect single phase….
but if as-cast, or not annealed for long enough,
might be surprised!

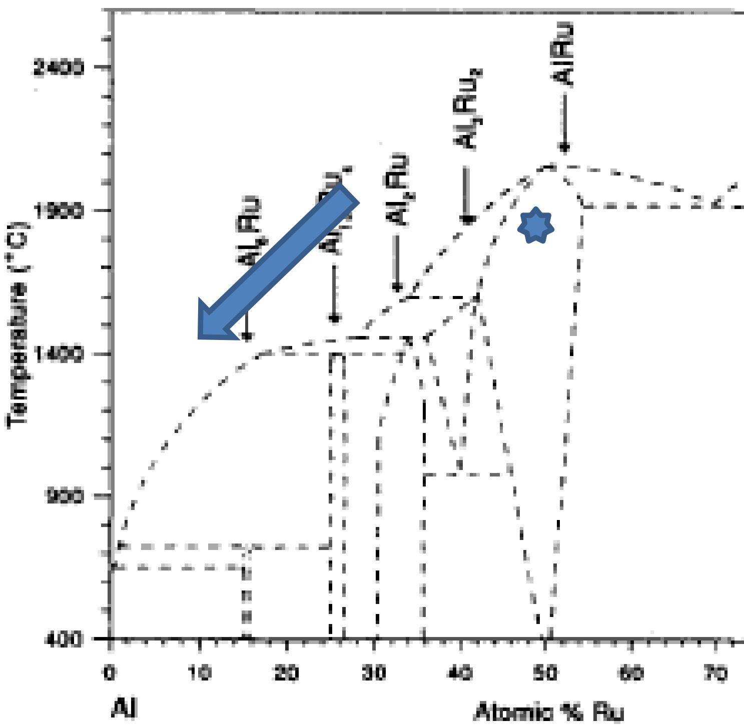
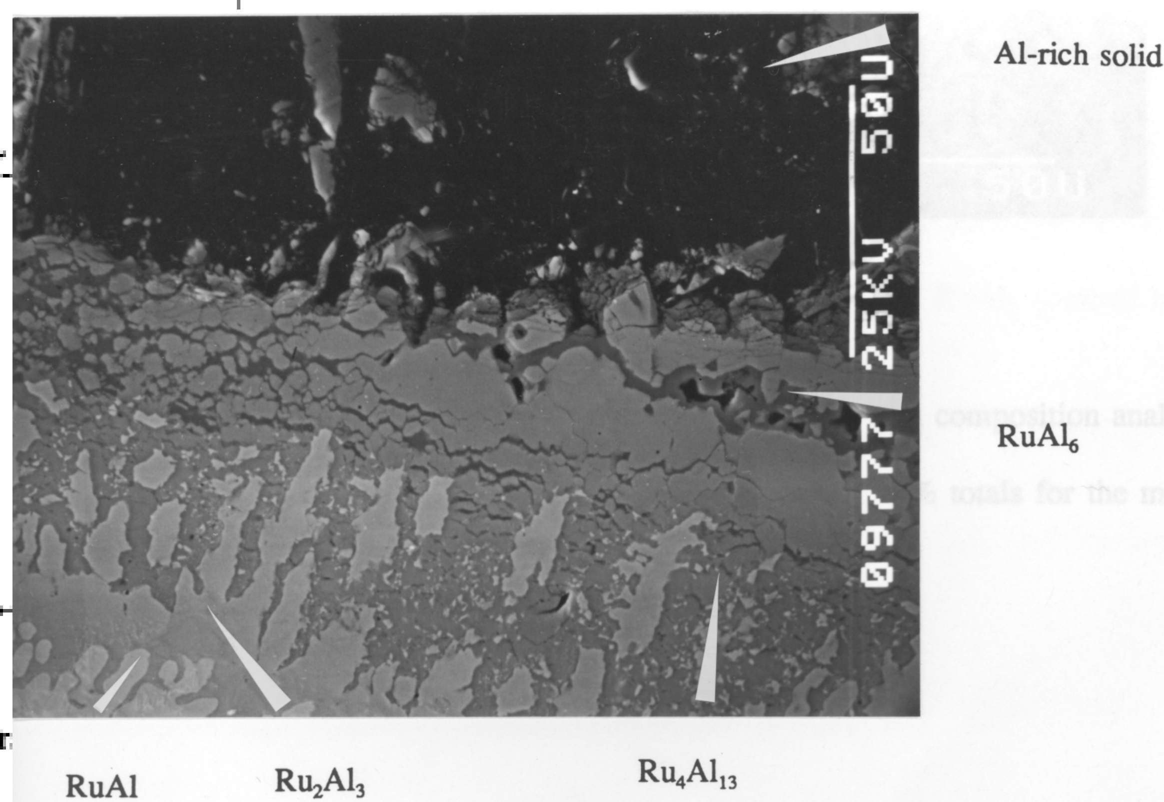
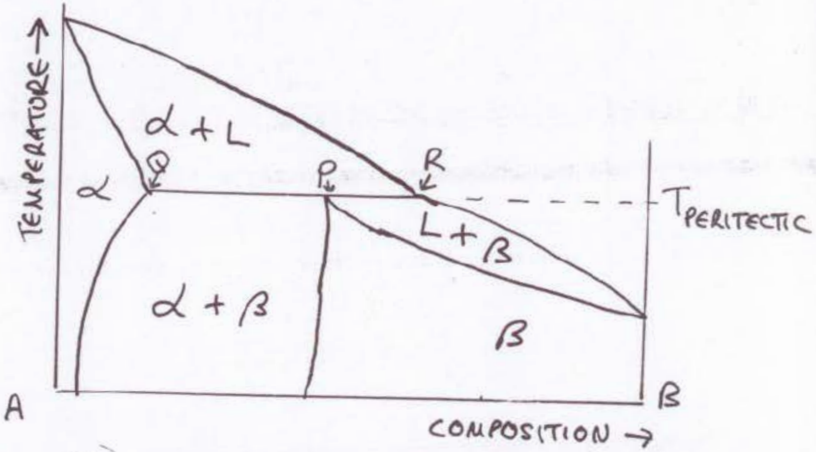


Fig. 9. Modified Al–Ru phase diagr



Peritectic Reaction: $L + \alpha \rightarrow \beta$

ie solid α forms and then reacts at a lower temperature with Liquid [to varying extent, depending on the composition] to form β.



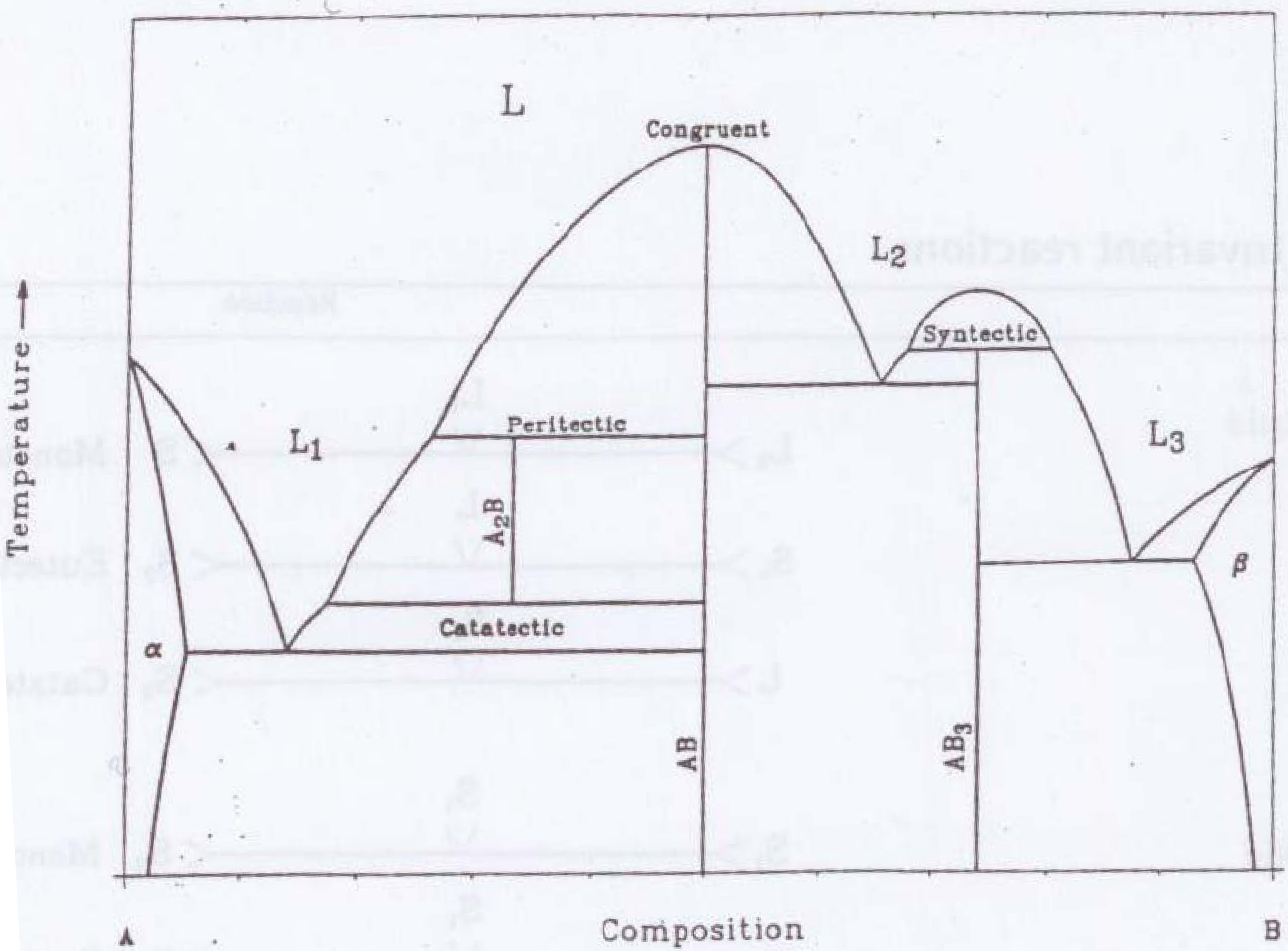
ANY alloy within QR composition undergoes the peritectic reaction

α forms first in all.

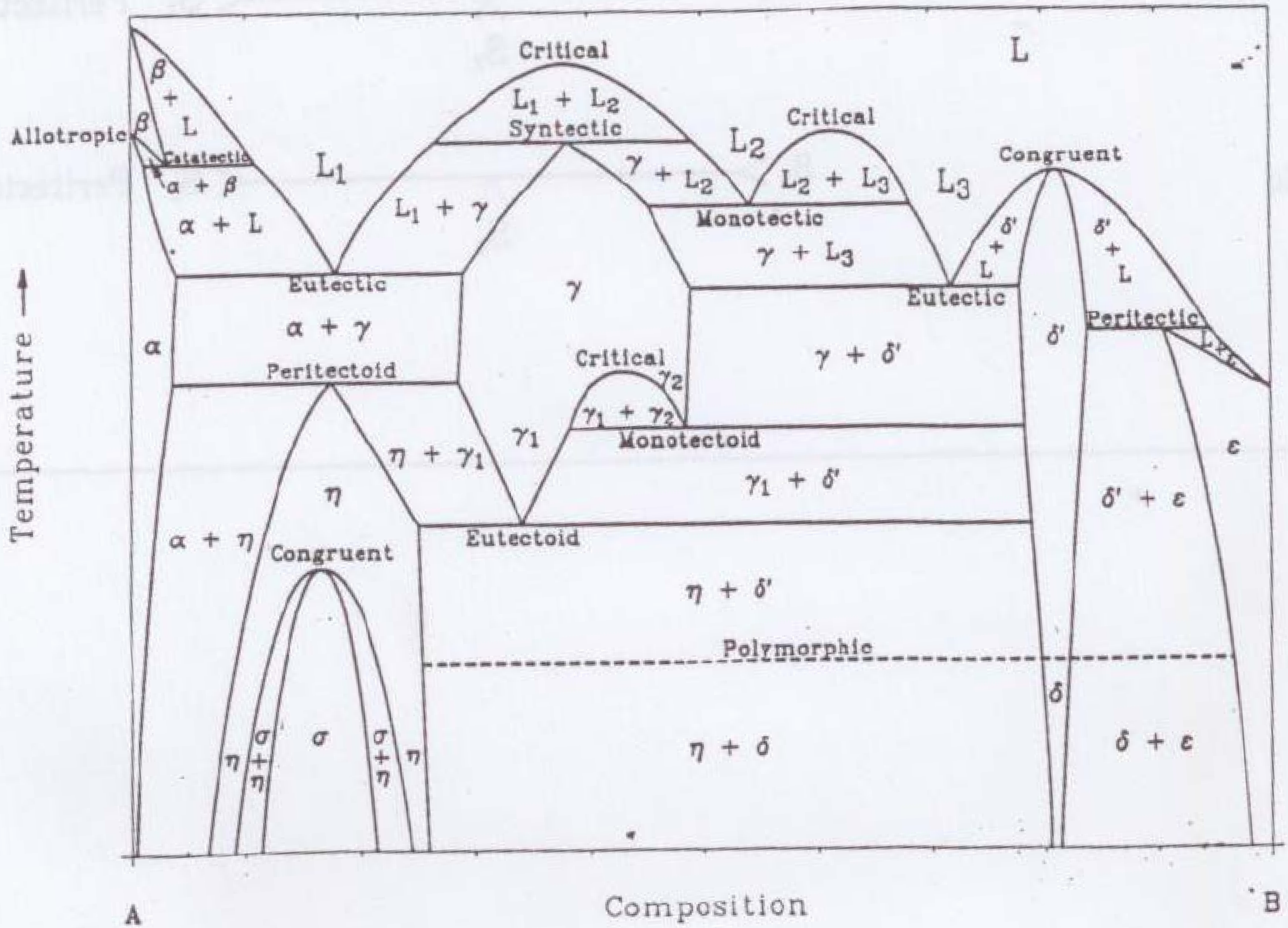
Between Q and P at T_p some of the α reacts with liquid to form β.

At P [Peritectic point] All α reacts → β formed

Between P & R :- All α reacts, some liquid left; later all solidifies → β



L
Congruent
L2
Syntectic
L1
Peritectic
L3
A2B
β
Catatectic
α
AB
AB3
Temperature
A
Composition
B



Hypothetical bi...

Invariant reactions

Type	Reaction
Eutectic (involves liquid and solid)	
Eutectoid (involves solid only)	
Peritectic (involves liquid and solid)	
Peritectoid (involves solid only)